0RQP-E0S12

Isolated DC-DC Converter

The 0RQP-E0S12 is an isolated DC/DC converter that operates from a nominal 48 VDC source. The unit provides up to 800 W of output power from a nominal 48 VDC input.

The unit is designed to be highly efficient and low cost. Features include remote on/off, short circuit protection, over current protection, under-voltage lockout, over temperature protection, power management bus communications and so on.

The converter is provided in an industry standard quarter brick package.

Key Features & Benefits

- 40 - 60 VDC Input
- 12 VDC @ 66.8 A Output
- 1/4th Brick Converter
- Fixed Frequency
- High Efficiency
- Input Under Voltage Lockout
- Input Over Voltage Lockout
- OCP/SCP
- Over Temperature Protection
- Over Voltage Protection
- Power Management Bus Communications
- Approved to IEC/EN 62368-1
- Class II, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)

RoHS Compliant

Applications

- Industrial
- Telecommunications

1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQP-E0S12AG 0RQP-E0S12BG 0RQP-E0S12PG	12 VDC	40 – 60 VDC	66.8 A	800 W	96.5%

PART NUMBER EXPLANATION

0	R	QP	-	E0	S	12	x	G
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Logic and Optional Features	Package Type
Through hole mount	RoHS	with power management bus interface		800 W	40 – 60 V	12 V	A - Active high, without droop B - Active low, without droop P - Active low, with droop	Tray package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Non-operating Input Voltage		-0.3	-	80	V
Input Transient Voltage	Operating transient ⩽ 100 ms	-	-	80	V
Remote On/Off		-0.3	-	18	V
PMBDATA		-0.3	-	3.3	V
PMBCLK		-0.3	-	3.3	V
SMBALERT		-0.3	-	3.3	V
Addr1		-0.3	-	3.3	V
Addr0		-0.3	-	3.3	V
C2		-0.3	-	3.3	V
Isolation Voltage	Input to output	-	-	1500	V
Ambient Temperature Long-Term	All components on the Unit meet IPC-9592 (latest revision) derating guidelines.	-40	-	85	°C
Ambient Temperature Short-Term	(96 hours/year). Unit's component temperatures exceed IPC-9592 (latest revision) derating guidelines but not exceed component temperature ratings.	-40	-	90	°C
Storage Temperature		-55	-	125	°C
Altitude		-	-	5000	m
Humidity		10	-	90	%

NOTE: Ratings used beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

3. INPUT SPECIFICATIONS

All specifications are typical at 25°C unless otherwise stated.

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Operating Input Voltage	Fully functioning for long term operation	40	48	60	V
Input Current (full load)	Vin = 40 V, Vo = 12 V, Io = 66.8 A	-	-	25	A
Input Current (no load)	Vin = 40 V, Vo = 12 V	-	150	200	mA
Remote Off Input Current		-	15	20	mA
Input Reflected Ripple Current is (RMS)	10 µH source impedance, Vin = 40 -60 V, Io = Io max. Refer to section 13 for detail input capacitance and waveforms	-	20	30	mA
Input Reflected Ripple Current is (PK-PK)	10 µH source impedance, Vin = 40-60 V, Io = Io max. Refer to section 13 for detail input capacitance and waveforms	-	60	110	mA
Input Terminal Ripple Current (RMS)	10 µH source impedance, Vin = 40-60 V, Io = Io max. Refer to section 13 for detail input capacitance and waveforms	-	1000	1500	mA
Under-voltage Turn off Threshold	Lockout turn off, non-latching	35	36.5	38	V
Under-voltage Turn on Threshold	Auto-recovery and non-latching.	36	38.5	39.5	V
Under-voltage Lockout Hysteresis Voltage		-	2	-	V
Over-voltage Recovery Threshold	Lockout turn off, non-latching	75	77	79	V
Over-voltage Shutdown Threshold	Auto-recovery and non-latching.	80	82	85	V
Over-voltage Lockout Hysteresis Voltage		-	5	-	V

CAUTION: This converter is not internally fused. An input line fuse must be used in application. Recommended input fast-acting fuse on system board.

4. OUTPUT SPECIFICATIONS

All specifications are typical at nominal input, full load at 25°C unless otherwise stated.

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Output Voltage Set Point	Test condition of the output set point: Vin = 48 V, Io = 50% load at 25°C ambient.	11.94	12.00	12.06	V
Output Voltage Range (without droop)	Vin = 40-60 V, resistive load, and temperature conditions until end of life	11.76	12.00	12.24	V
Output Voltage Range (with droop)	Vin = 40-60 V, resistive load, and temperature conditions until end of life	11.63	12.00	12.37	V
Load Regulation (without droop)	Io = 0~100% load (Vin = 40-60 V)	-	20	40	mV
Load Regulation (with droop)	Io = 0~100% load (Vin = 40-60 V)	-	500	-	mV
Line Regulation	Vin = 40~60 V	-	20	60	mV
Regulation Over Temperature		-	150	200	mV
Output Ripple and Noise (pk-pk)	Vin = 48V, Io = 100% load at 25°C ambient, 5 Hz - 20 MHz BW, 270 µF / 16 V (OS-CON)	-	75	150	mV
Output Ripple and Noise (rms)	Vin = 48V, Io = 100%load at 25°C ambient, 5 Hz - 20 MHz BW, 270 µF / 16 V (OS-CON)	-	20	30	mV
Output Current Range		0	-	66.8	A
Output DC Current Limit	Hiccup mode	73	80.2	87	A
Rise Time	Trise=Time for Vo to rise from 10% to 90% of Vo,set	-	12	20	ms
Turn-On Delay (Vin)	Tdelay=Time until Vo = 10% of Vo,set Enable with Vin	-	29	35	ms
Turn-On Delay (on/off)	Tdelay=Time until Vo = 10% of Vo,set Enable with on/off	-	18	20	ms
Overshoot at Turn on		-	0	3	%
Undershoot at Turn off		-	0	3	%
Output Capacitance		270	-	10000	µF
Transient Response					
ΔV 50%~75% of Max Load	di/dt = 0.1 A/µs, Vin = 48 VDC, Ta=25°C, Tested with a 270 µF / 16 V (OS-CON)	-	250	350	mV
Settling Time		-	-	700	µs
ΔV 75%~50% of Max Load		-	250	350	mV
Settling Time		-	-	700	µs

5. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Io = 100% Irate	94	96.5	97.5	%
	Io = 60% Irate	94	96.6	97.5	%
Switching Frequency		-	150	-	kHz
MTBF	Calculated Per Bell Core SR-332 (Vin = 48 V, Vo = 12 V, Io = 80% Iomax A, Ta = 40°C, Airflow = 200 LFM, FIT = 10^9/MTBF)	-	3.5	-	M hrs
FIT		-	55	-	10^9/Hours
Over Temperature Protection		-	130	-	°C
Over Voltage Protection (Static)	Latching mode	12.8	-	14	V
Weight		-	85	-	g
Dimensions (L × W × H)			2.30 x 1.45 x 0.57		inch
			58.42 x 36.83 x 14.48		mm
Isolation Characteristics					
Input to Output		-	-	1500	VDC
Input to Heatsink		-	-	1500	VDC
Output to Heatsink		-	-	500	VDC
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	-	3300	pF

6. EFFICIENCY DATA

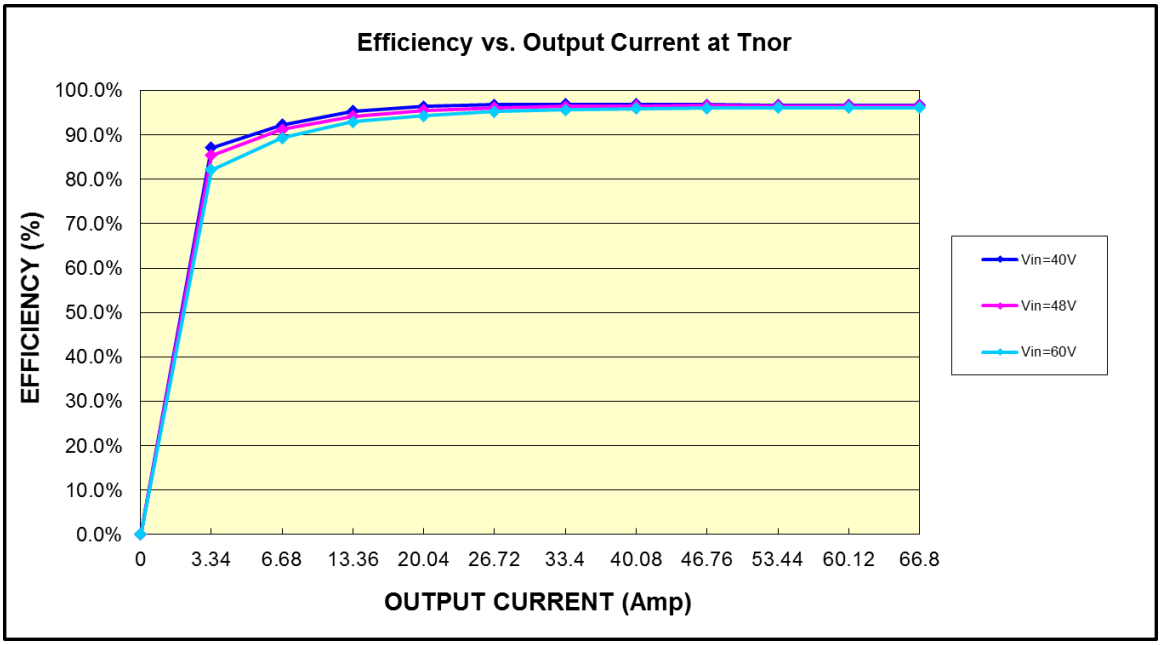


Figure 1. Efficiency data

7. REMOTE ON/OFF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Signal Low (Unit On)	Active Low	Remote On/Off pin is open, the module is off	-0.3	-	0.8	V
Signal High (Unit Off)			2.4	-	18	V
Signal Low (Unit Off)	Active High	Remote On/Off pin is open, the module is on	-0.3	-	0.8	V
Signal High (Unit On)			2.4	-	18	V
Current Sink		Remote on/off pin is pulled up to 10 V.	0	-	1000	µA
Source Current		Remote on/off pin is pulled down to 0 V.	-	-	200	µA
Remote Open circuit voltage			-	-	15	V

Recommended remote on/off circuit for active low

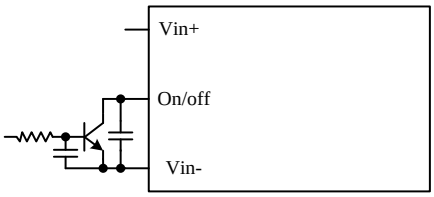


Figure 2. Control with open collector/drain circuit

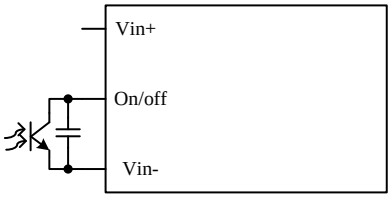


Figure 3. Control with photocoupler circuit

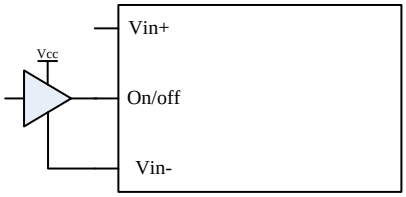


Figure 4. Control with logic circuit

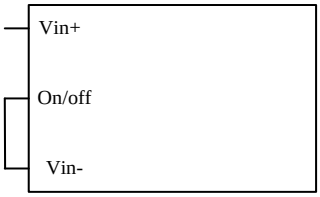


Figure 5. Permanently on

Recommended remote on/off circuit for active high

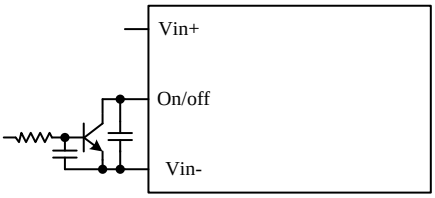


Figure 6. Control with open collector/drain circuit

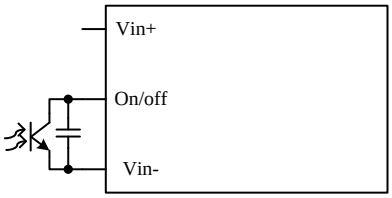


Figure 7. Control with photocoupler circuit

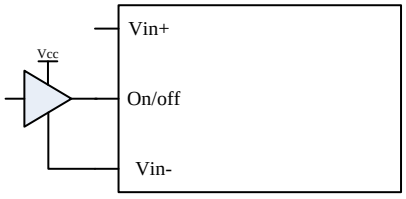


Figure 8. Control with logic circuit

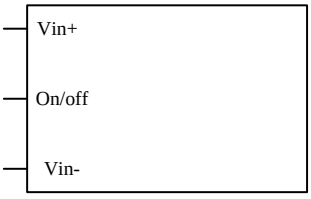


Figure 9. Permanently on

8. INPUT NOISE

Input reflected ripple current

Testing setup:

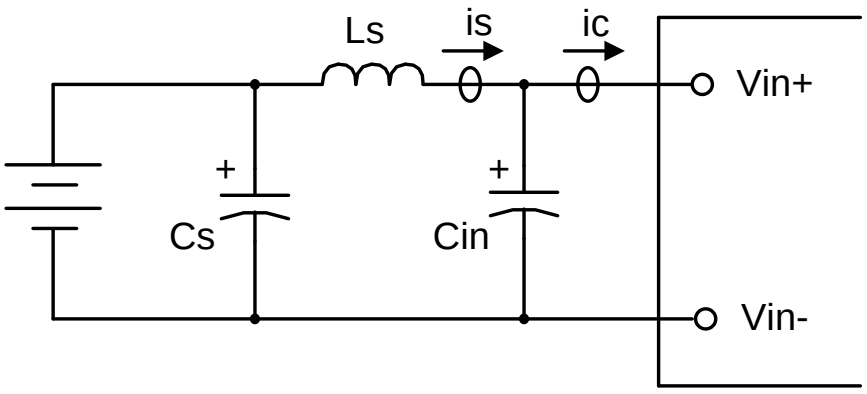


Figure 10.

Notes and values in testing.

is: Input Reflected Ripple Current
ic: Input Terminal Ripple Current
Ls: Simulated Source Impedance (12 µH)
Cs: Offset possible source Impedance (100 µF, ESR<0.1Ω @ 100 kHz, 20°C)
Cin: Electrolytic capacitor, should be as closed as possible to the power module to damped ic ripple current and enhance stability. Recommendation: 100µF, ESR<0.12 Ω @ 100 kHz, 20°C.

Below measured waveforms are based on above simulated and recommended inductance and capacitance.

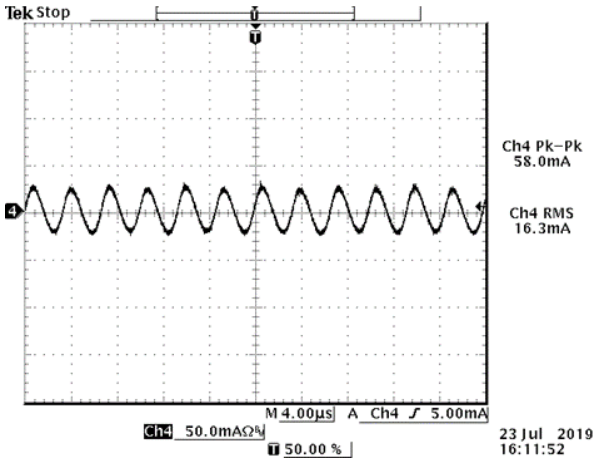


Figure 11. is (input reflected ripple current), AC component

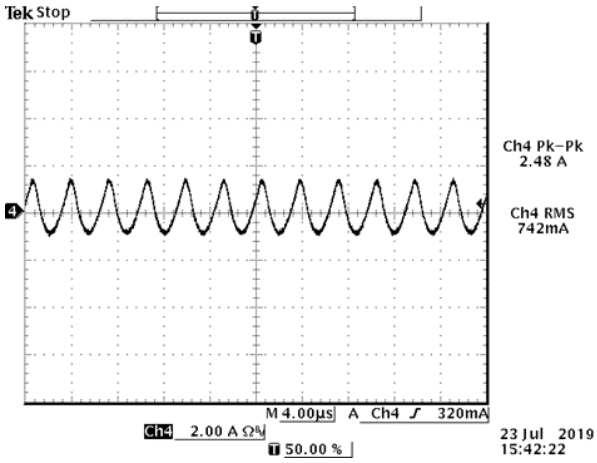


Figure 12. ic (input terminal ripple current), AC component

Test condition: 48 VDC input, 12 VDC / 66.8 A output and Ta = 25 °C

9. RIPPLE AND NOISE WAVEFORM

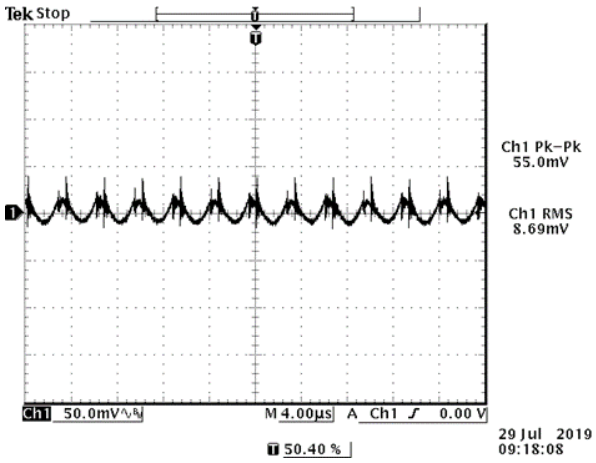


Figure 13. Ripple and noise waveform

Note: 48 VDC input, 12 VDC / 66.8 A output and Ta = 25 °C, 270 µF/16V (OS-CON).

10. TRANSIENT RESPONSE WAVEFORMS

Transient Response test condition: di/dt = 0.1 A/µs, 270 µF / 16V (OS-CON) CHI: Vout, CH2: Iout

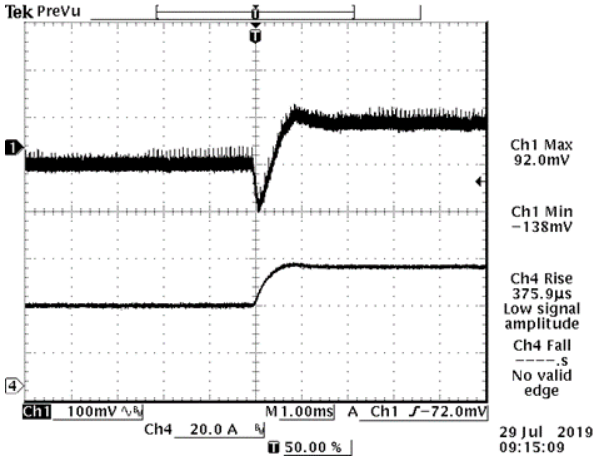


Figure 14. Vout = 12 V 50%-75% Load Transients at Vin = 48 V, Ta = 25 °C (0.1 A/µs）

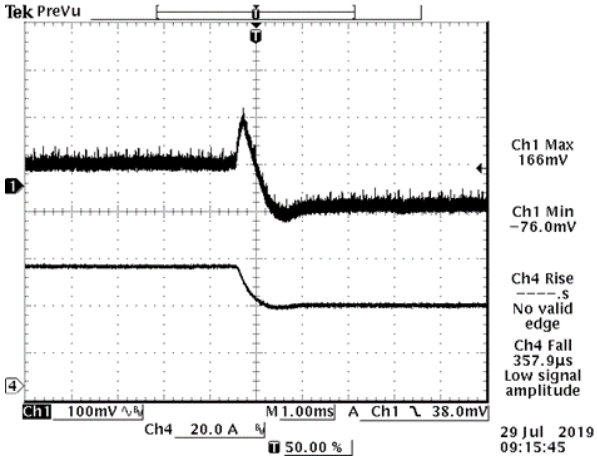


Figure 15. Vout = 12 V 75%-50% Load Transients at Vin = 48 V, Ta = 25 °C (0.1 A/µs）

11. STARTUP & SHUTDOWN

Rise Time

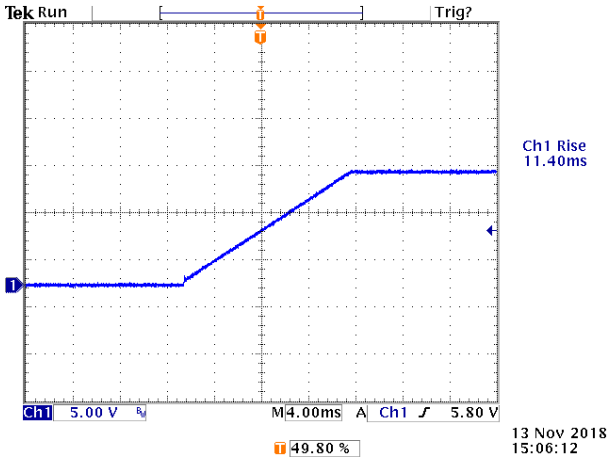


Figure 16. Vout = 12 V / 0 A @ Vin = 48 V, Ta = 25°C, Cext = 0 µF

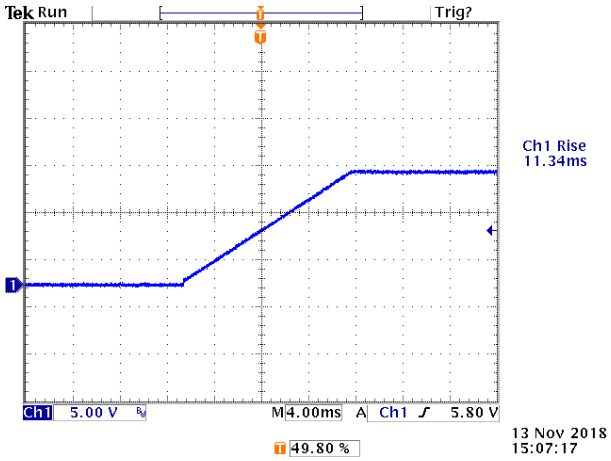


Figure 17. Vout = 12 V / 0 A @ Vin = 48 V, Ta = 25°C, Cext = 10000 µF

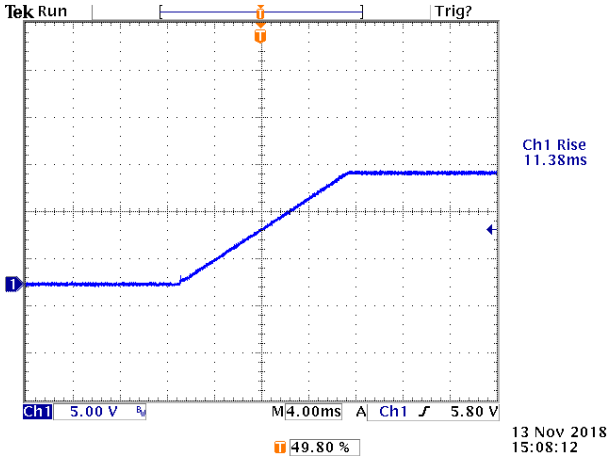


Figure 18. Vout = 12 V / 66.8 A @ Vin= 48 V, Ta = 25°C, Cext = 0 µF

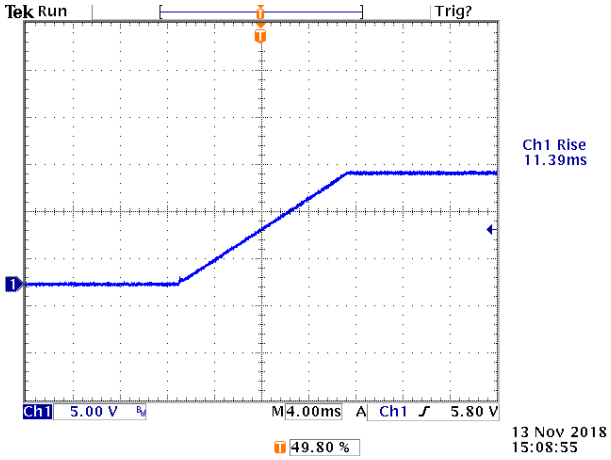


Figure 19. Vout = 12 V / 66.8 A @ Vin = 48V, Ta = 25°C, Cext = 10000 µF

Startup

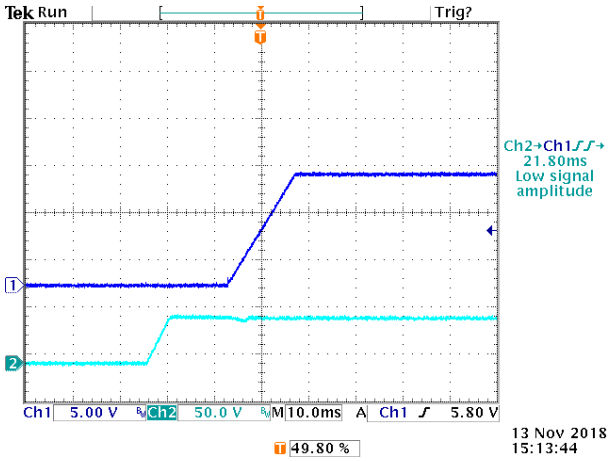


Figure 20. Startup from Vin
CH1: Vo
CH2: Vin
Vout = 12 V / 66.8 A @ Vin = 48 V, Ta = 25°C

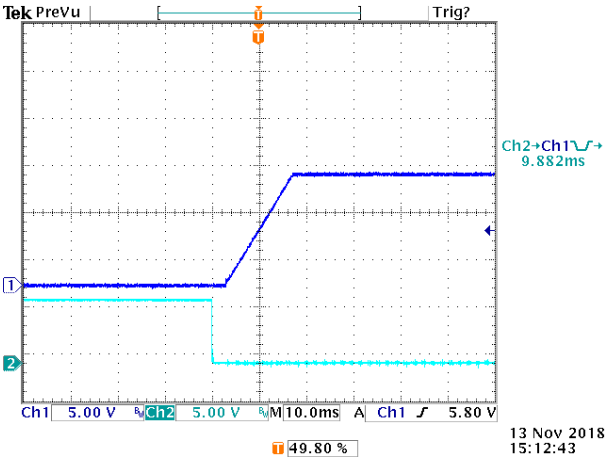


Figure 21. Startup from on/off
CH1: Vo
CH2: on/off
Vout = 12 V / 66.8 A @ Vin = 48 V, Ta = 25°C

Shutdown

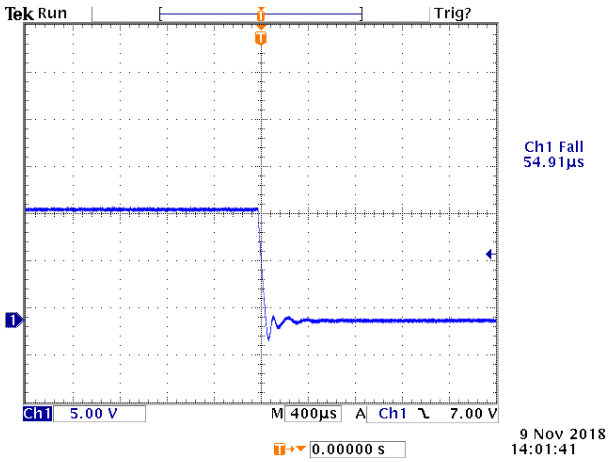


Figure 22. Vout = 12 V / 66.8 A @ Vin = 48 V, Ta = 25°C

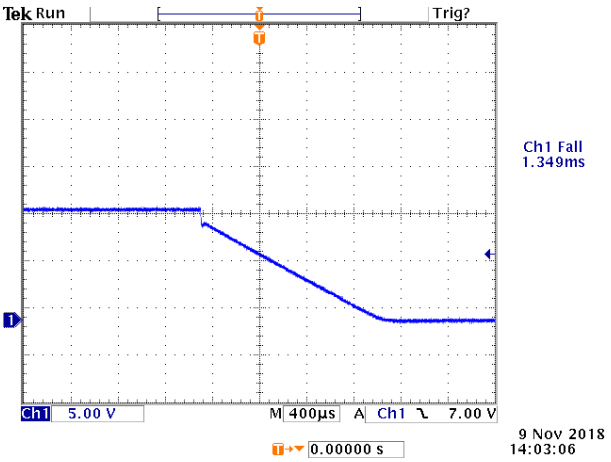


Figure 23. Vout = 12 V / 66.8 A @ Vin = 48 V, Ta = 25°C, Cext = 10000 µF

12. THERMAL DERATING CURVES

Maximum junction temperature of semiconductors derated to 125 °C.

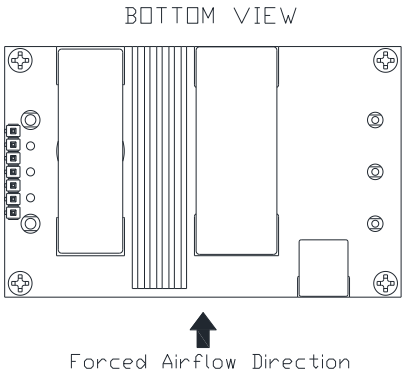


Figure 24. Airflow direction

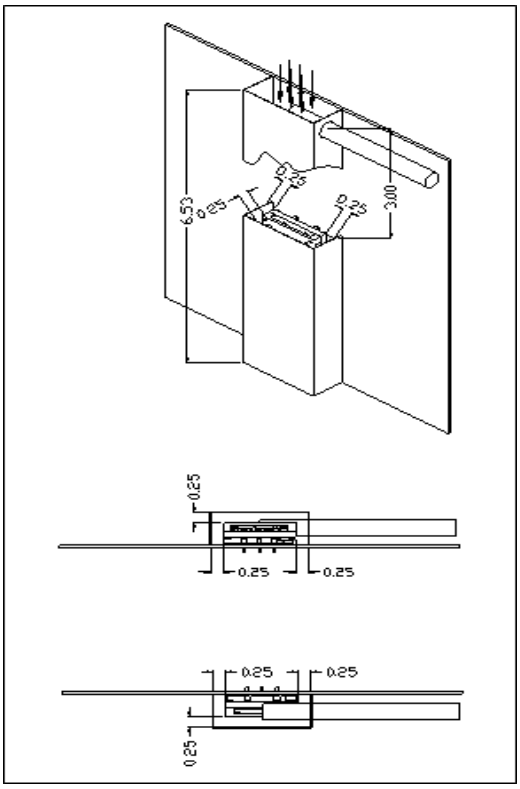


Figure 25. Thermal test setup

Vin = 48 V
Output Current Derating for the Base
Plate version with a cover in the Transverse Orientation.
Airflow Direction from Vin(-) to Vin(+).

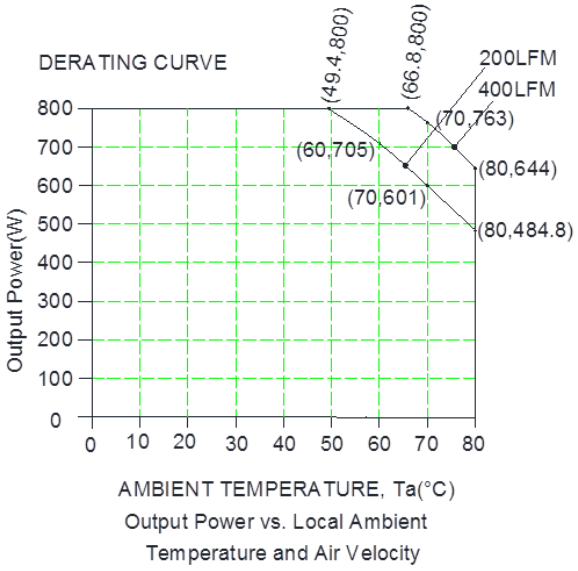


Figure 26. Thermal derating curve

Note: Output power vs. ambient temperature and air velocity @ Vin = 50 V (Longitudinal Orientation, airflow from Vin(-) to Vin(+)

13. UNDER VOLTAGE LOCKOUT

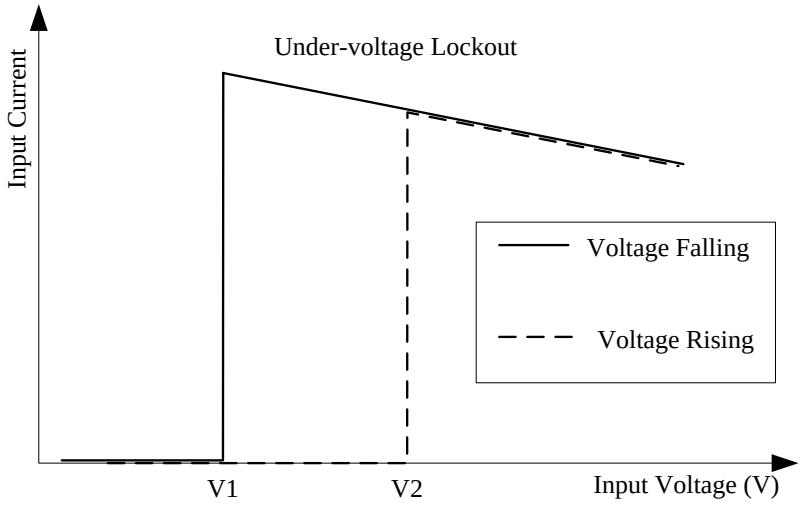


Figure 27. Under voltage lockout
V1 = 36.5 V
V2 = 38.5 V

14. SAFETY&EMC

Safety:

Approved to IEC/EN 62368-1

EMC:

Compliance to EN 55032 class A (both peak and average) with the following inductive and capacitive filter

Test setup:

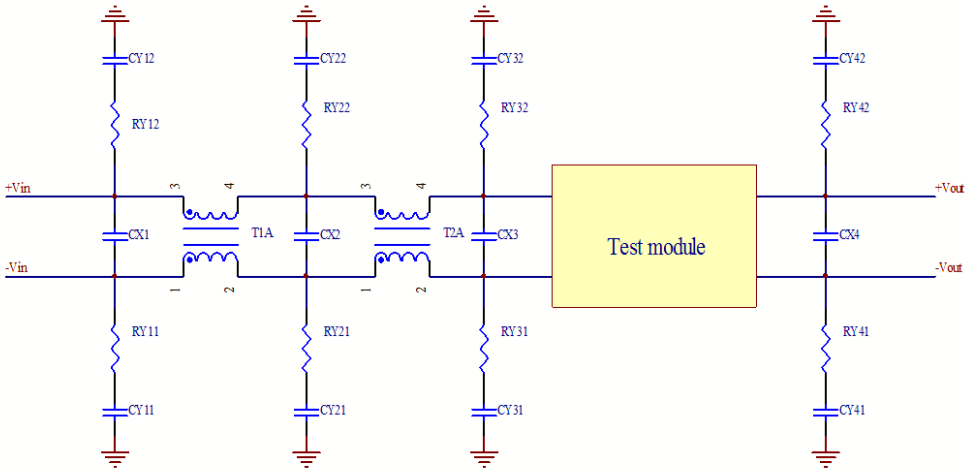


Figure 28.

T1A	CX1	CX4	CY22	CY42	
3mH Common mode Choke	CAP X2 1μF+/-20% 310VAC	Chip Cap 2.2μF*10 +AL Cap 47μF	CAP Y2 4700PF+/-20% 250VAC	CAP Y2 4700PF+/-20% 250VAC	-
T2A	CX2	CY21	CY41		
3mH Common mode Choke	CAP X2 1μF+/-20% 305VAC	CAP Y2 4700PF+/-20% 250VAC	CAP Y2 4700PF+/-20% 250VAC	-	-
-					

Positive:

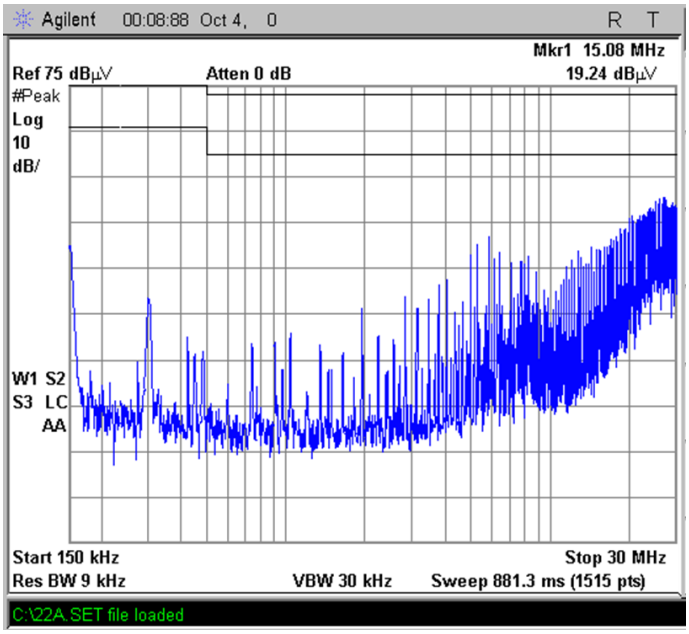


Figure 29.

Negative:

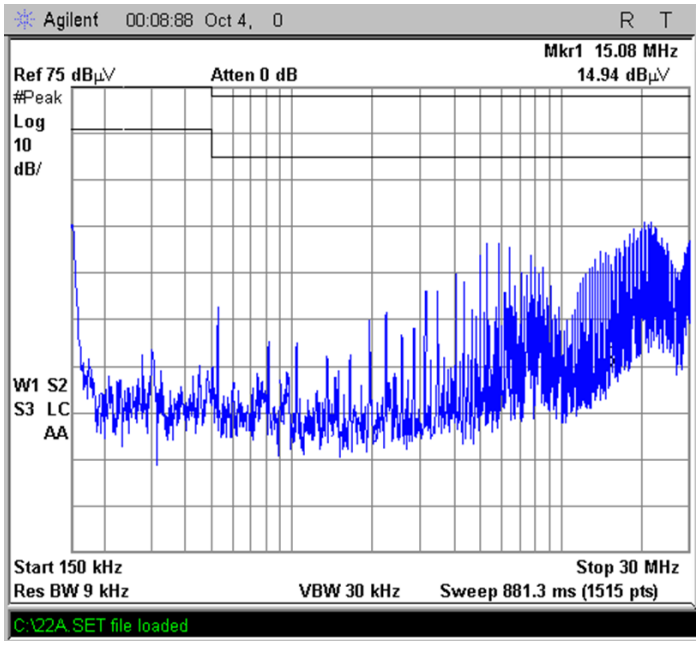


Figure 30.

15. POWER MANAGEMENT BUS

DIGITAL FEATURE DESCRIPTIONS

The module supports Power Management Bus to allow to be monitored, controlled and configured by the system. More detailed Power Management Bus information can be found in the Power Management Bus Power Management Protocol Specification, Part I and part II, revision 1.3, which is shown in the System Management Interface Forum Web site: www.powerSIG.org. The supported Power Management Bus commands of the module are listed below in the supported Power Management Bus commands section. The module supports four Power Management Bus signal lines: Data, Clock, SMBALERT (optional), Control (C2 pin, optional), and two Address lines: Addr0 and Addr1. Connection for the Power Management Bus interface should follow the High-Power DC specifications given in section 3.1.3 in the SMBus specification V2.0 or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is shown in http://smbus.org. 100 kHz communication bus speed is preferred.

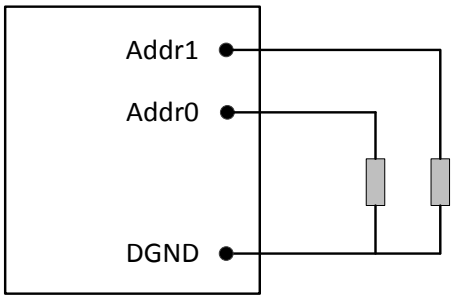
SMBALERT protocol is also supported by the module. SMBALERT line is also a wired-AND signal, by which the module can alert the Power Management Bus master via pulling the SMBALERT pin to an active low. There is only one way that the master and the module response to the alert of SMBALERT line. The master will communicate with the slave module using the programmed address, and using the various READ_STATUS commands to find the cause for the SMBALERT. The CLEAR_FAULTS command will clear the SMBALERT.

The module also supports the Packet Error Checking (PEC) protocol. It can check the PEC byte provided by the Power Management Bus master, and include a PEC byte in all message transmitted back to the master.

Power Management Bus Addressing

The Module has flexible power management bus addressing capability. When connect different resistor from Addr0 and Addr1 pin to DGND pin, 64 possible addresses can be acquired. The address is in the form of octal digits; Each pin offers one octal digit, and then combine together to form the decimal address as shown in below.

Address = 8 * ADDR1 + ADDR0



Octal digit	Resistor (kohm)
0	10
1	15.4
2	23.7
3	36.5
4	54.9
5	84.5
6	130
7	200

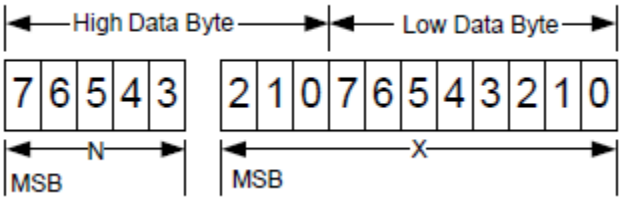
Corresponded to each octal digit, the requested resistor values are shown in below, and +/-1% resistors accuracy can be accepted. If there are any resistances exceeding the requested range, address 64 will be return. 0-12 and 40, 44, 45, and 55 in decimal address cannot be used, since they are reserved according to the SMBus specifications, and which will also return address 64.

NOTE:

1. Power Management Bus communication is only supported when vin normal and remote on
2. If boot load function is needed, there can not be an I2C slave address of 0x58 on I2C bus

Power Management Bus Data Format

For commands which is except to the output voltage, including input voltage, output current, temperature, PWM frequency, duty cycle, the controller will use the 2-byte linear format as defined by the Power Management Bus system management protocol. The linear data format contains 2 bytes which include a 5-bit two's complement exponent and an 11-bit two's complement mantissa. The communicated value Y is received and reported as $Y = X*2^N$

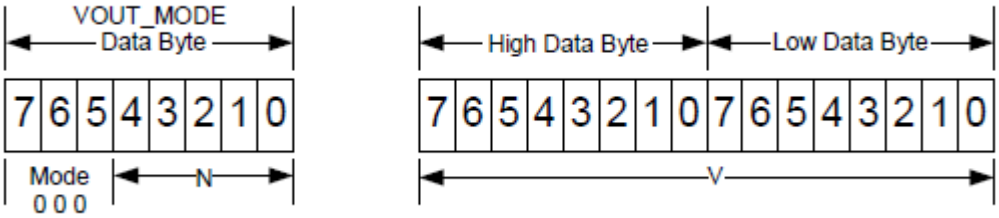


For example, to set the over temperature fault threshold 135 deg C by OT_FAULT_LIMIT command, the read/write data can be calculated refer to below:

The binary number of N is 0, whose decimal is 0.

$X = OT\_FAULT\_LIMIT /2^{(0)} = 135$, whose binary is 0b00010000111.

Combine X and N, the binary is 0b0000000010000111. The hexadecimal of OT_FAULT_LIMIT is 0x0087.



The controller will receive output voltage parameters and report output voltage values using the Power Management Bus Vout linear format. The voltage will be in the form $Voltage = V*2^N$. The Mantissa and exponent in this equation will be read and reported using 3 bytes. The first byte is the VOUT_MODE byte which will always contain 000 in the 3 MSB's. The 5 LSB's are the exponent. The exponent N is fixed and equals -10. The other 2 bytes N will contain the Mantissa. In the above format N is a 5-bit two's complement binary integer and V is a 16-bit unsigned binary integer. All 16 bits are reported to be compatible with the Power Management Bus protocol.

For example, to set Vout to 12V by VOUT_COMMAND, the read/write data can be calculated refer to below process:

$V = Vout/2^{(-10)} = 12/2^{(-10)} = 12288$.

Convert the decimal to hexadecimal 0x3000. So the VOUT_COMMAND is 0x3000.

SUPPORTED POWER MANAGEMENT BUS COMMANDS

The main Power Management Bus commands described in the Power Management Bus 1.3 specification are supported by the module. Partial Power Management Bus commands are fully supported; Partial Power Management Bus commands have difference with the definition in Power Management Bus 1.3 specification. All the supported Power Management Bus commands are detailed summarized in the below table.

Command	Code	Command Description	Type	Data format	Default value	Data units	Note
OPERATION	0x01	Configures the operational state of the module	R/W byte	Bit field	0x80	/	1
ON_OFF_CONFIG	0x02	Configures the combination of CONTROL pin input and serial bus commands needed to turn the module on and off	Read byte	Bit field	0x1C	/	1,2
CLEAR_FAULTS	0x03	Clear any fault bits that have been set	Send byte	/	/	/	/
RESTORE_DEFAULT_ALL	0x12	Restore the factory settings to the non-volatile memory	Write	/	/	/	5
STORE_USER_ALL	0x15	Store the current settings to the non-volatile memory	Write	/	/	/	5
VOUT_MODE	0x20	Vo data format	Read byte	mode + exponent	0x16	/	/
VOUT_COMMAND	0x21	Set the output voltage normal value	R/W word	Vout linear	12/12.2	Volts	8
VOUT_MAX	0x24	Set an upper limit on the output voltage the module can command	Read word	Vout linear	12.6	Volts	/
VOUT_MARGIN_HIGH	0x25	Set the output voltage margin high value	Read word	Vout linear	12.5	Volts	/
VOUT_MARGIN_LOW	0x26	Set the output voltage margin low value	Read word	Vout linear	10	Volts	/
VOUT_MIN	0x2B	Set a lower limit on the output voltage the module can command	Read word	Vout linear	9	Volts	/
MAX_DUTY	0x32	Set the maximum duty cycle	Read word	Linear	50	%	/
FREQUNCY_SWITCH	0x33	Set the primary side switching frequency	Read word	Linear	150	kHz	/
VOUT_OV_FAULT_LIMIT	0x40	Set the output over voltage fault threshold	R/W word	Vout linear	13.5	Volts	4
VOUT_OV_FAULT_RESPONSE	0x41	Instructs what action to take in response to an output overvoltage fault	R/W byte	Bit field	0x80	/	1
IOUT_OC_FAULT_LIMIT	0x46	Set the output overcurrent fault threshold	R/W word	Linear	80	A	3,4
IOUT_OC_FAULT_RESPONSE	0x47	Instructs what action to take in response to an output overcurrent fault	R/W byte	Bit field	0xF8	/	1
OT_FAULT_LIMIT	0x4F	Set the over temperature fault threshold	R/W word	Linear	135	Deg C	3,4
OT_FAULT_RESPONSE	0x50	Instructs what action to take in response to an over temperature fault	R/W byte	Bit field	0xB8	/	1
MFR_C1_C2_CONFIG	0x6C	Configure C2 pin function	R/W byte	Bit field	0x00	/	1
MFR_C2_CONFIG	0x6D	Configure C2 pin logic	R/W byte	Bit field	0x00	/	1
MFR_PGOOD_POLARITY	0x6E	Configure power good logic	R/W byte	Bit field	0x00	/	1
STATUS_WORD	0x79	Returns the information with a summary of the unit's fault condition	Read word	Bit field	0	/	1,6
STATUS_VOUT	0x7A	Returns the information with a summary of the unit's output voltage condition	Read byte	Bit field	0	/	1,6
STATUS_IOUT	0x7B	Returns the information with a summary of the unit's output current condition	Read byte	Bit field	0	/	1,6
STATUS_TEMPERATURE	0x7D	Returns the information with a summary of the unit's temperature condition	Read byte	Bit field	0	/	1,6
STATUS_CML	0x7E	Returns the information with a summary of the unit's communication condition	Read byte	Bit field	0	/	1,6
READ_VIN	0x88	Returns the input voltage of the module	Read word	Linear	/	Volts	/
READ_VOUT	0x8B	Returns the output voltage of the module	Read word	Vout Linear	/	Volts	/

Command	Code	Command Description	Type	Data format	Default value	Data units	Note
READ_IOUT	0x8C	Returns the output current of the module	Read word	Linear	/	A	/
READ_TEMPERATURE_1	0x8D	Returns the temperature of the module	Read word	Linear	/	Deg C	/
POWER MANAGEMENT BUS_REVISION	0x98	Reads the revision of the Power Management Bus	Read byte	Bit field	0x33	/	1
MFR_ID	0x99	Reads the ID of the manufacture	Read block	ASCII	BELF	/	1
FIRMWARE_REV	0x9B	Reads the revision of the firmware	Read block	ASCII	A1	/	7

NOTES:

1. Refer to below detailed description
2. OPERATION command controls module on/off
3. Before write operation, it is necessary to read the register data and parse out the corresponding linear format N value, then convert write value based on N.
4. In order to ensure that the product works properly, the adjustment range of the protection limit value is limited, when the set value exceeds the upper or lower limits, the lower limit value is automatically set. The following table shows the upper and lower limits

Command	Code	The low limit	The upper limit
VOUT_OV_FAULT_LIMIT	0x40	13	14
IOUT_OC_FAULT_LIMIT	0x46	20	150
OT_FAULT_LIMIT	0x4F	120	140

5. Read or write this command, PSU will shut down until next vin power cycle
6. ALL the fault bits set in all the status registers remain set, even if the fault condition is removed or corrected, until one of the following occur:
   1) A remote off then remote on cycle;
   2) The device receives a CLEAR_FAULTS command;
   3) Vin power is removed from the module.
7. Block read command, byte count=2.
8. No-load condition, Default value is 12.2V(With droop); Default value is 12V(Without Droop).

OPERATION (0x01)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Turn the module on/off	1	on	1
		0	off	
6	Not supported	/	/	0
5:4	Control the source of the output voltage command	00	VOUT_COMMAND	00
		01	VOUT_MARGIN_LOW	
		10	VOUT_MARGIN_HIGH	
		11	Not supported	
3:0	Reserved or Not supported	/	/	0000

ON_OFF_CONFIG (0x02)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:5	Reserved	/	/	000
4	Module powers up regardless of the state of the CONTROL pin and OPERATION command or not	0	Not supported	1
		1	Wait CONTROL and OPERATION	
3	Module powers up regardless of the state of the OPERATION command or not	0	Not supported	1
		1	Wait OPERATION command	
2	Module powers up regardless of the state of the CONTROL pin or not (Not supported)	0	Not supported	1
		1	Wait CONTROL pin	
1:0	Not supported	/	/	00

VOUT_OV_FAULT_RESPONSE (0x41)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00	Not supported	10
		01	Not supported	
		10	The module shuts down and response according to the retry setting in bits [5:3]	
		11	Not supported	
5:3	Retry setting	000	Module does not attempt to restart until a RESET signal or OPERATION command or Bias power is removed	000
		001-110	Not supported	
		111	Attempts to restart continuously until it is commanded off	
2:0	Delay time	/	Not supported	000

IOUT_OC_FAULT_RESPONSE (0x47)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00	Not supported	11
		01	Not supported	
		10	Not supported	
		11	The module shuts down and response according to the retry setting in bits [5:3]	
5:3	Retry setting	000	Module does not attempt to restart until a RESET signal or OPERATION command or Bias power is removed	111
		001-110	Not supported	
		111	Attempts to restart continuously until it is commanded off	
2:0	Delay time	/	Not supported	000

OT_FAULT_RESPONSE (0x50)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00	Not supported	10
		01	Not supported	
		10	The module shuts down and response according to the retry setting in bits [5:3]	
		11	Not supported	
5:3	Retry setting	000	Module does not attempt to restart until a RESET signal or OPERATION command or Bias power is removed	111
		001-110	Not supported	
		111	Attempts to restart continuously until it is commanded off	
2:0	Delay time	/	Not supported	000

MFR_C1_C2_CONFIG (0x6C)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:4	Reserved	/	/	0000
3:0	Pin configuration	0000	C2 pin: POWER_GOOD	0000
		0010	C2 pin: ON/OFF (Secondary)	

MFR_C2_CONFIG (0x6D)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:2	Reserved	/	/	000000
1	ON/OFF Configuration	1	And- Primary and secondary side on/off	0
		0	C2 pin signal is ignored	
0	Secondary Side ON/OFF logic	1	Positive Logic (High level enable: input > 2.64V)	0
		0	Negative Logic (Low level enable: input < 0.66V)	

MFR_PGOOG_POLARITY (0x6E)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:1	Reserved	/	/	0000000
0	Power Good Logic	1	Positive PGOOD logic	0
		0	Negative PGOOD logic	

STATUS_WORD (0x79)				
HIGH BYTE				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	VOUT	1	An output voltage fault has occurred	0
		0	Not occurred	
6	IOUT/POUT	1	An output current or output power fault has occurred	0
		0	Not occurred	
5	INPUT (Not supported)	1	An input overvoltage fault has occurred	0
		0	Not occurred	
4	Not supported	/	/	0
3	Power_Good	1	Power_Good signal is negated	0
		0	Power_Good signal is ok	
2:1	Not supported	/	/	00
0	UNKNOWN	1	A fault type not given in bits [15:1] of the STATUS_WORD has been detected	0
		0	Not occurred	

STATUS_WORD (0x79)				
LOW BYTE				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Busy	1	A fault was declared because the device was busy and unable to respond	0
		0	Not occurred	
6	Off	1	This bit is asserted if the unit is not providing power to the output, regardless of the reason, including simply not being enabled	0
		0	Not occurred	
5	VOUT_OV_FAULT	1	An output overvoltage fault has occurred	0
		0	Not occurred	
4	IOUT_OC_FAULT	1	An output overcurrent fault has occurred	0
		0	Not occurred	
3	VIN_UV_FAULT (Not supported)	1	An input under voltage fault has occurred	0
		0	Not occurred	
2	TEMPERATURE	1	A temperature fault has occurred	0
		0	Not occurred	
1	CML	1	A communication, memory or logic fault has occurred	0
		0	Not occurred	
0	NONE_OF_THE_ABOVE	1	A fault not listed in bits [7:1] of this byte has occurred	0
		0	Not occurred	

STATUS_VOUT (0x7A)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	VOUT_OV_FAULT	1 0	Occurred Not occurred	0
6:5	Reserved or Not supported	/	/	00
4	VOUT_UV_FAULT	1 0	Occurred Not occurred	0
3:0	Not supported	/	/	0000

STATUS_IOUT (0x7B)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	IOUT_OC_FAULT	1 0	Occurred Not occurred	0
6:0	Not supported	/	/	0000000

STATUS_TEMPERATURE (0x7D)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	OT_FAULT	1 0	Occurred Not occurred	0
6:0	Reserved or Not supported	/	/	0000000

STATUS_CML (0x7E)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Invalid or unsupported command received	1 0	Occurred Not occurred	0
6:0	Reserved or Not supported	/	/	0000000

POWER MANAGEMENT BUS_REVISION (0x98)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:4	Indicate the revision of Power Management Bus specification Part I to which the device is compliant	0000 0001 0010 0011	1 1.1 1.2 1.3	1.3
3:0	Indicate the revision of Power Management Bus specification Part II to which the device is compliant	0000 0001 0010 0011	1 1.1 1.2 1.3	1.3

16. MECHANICAL DIMENSIONS

OUTLINE

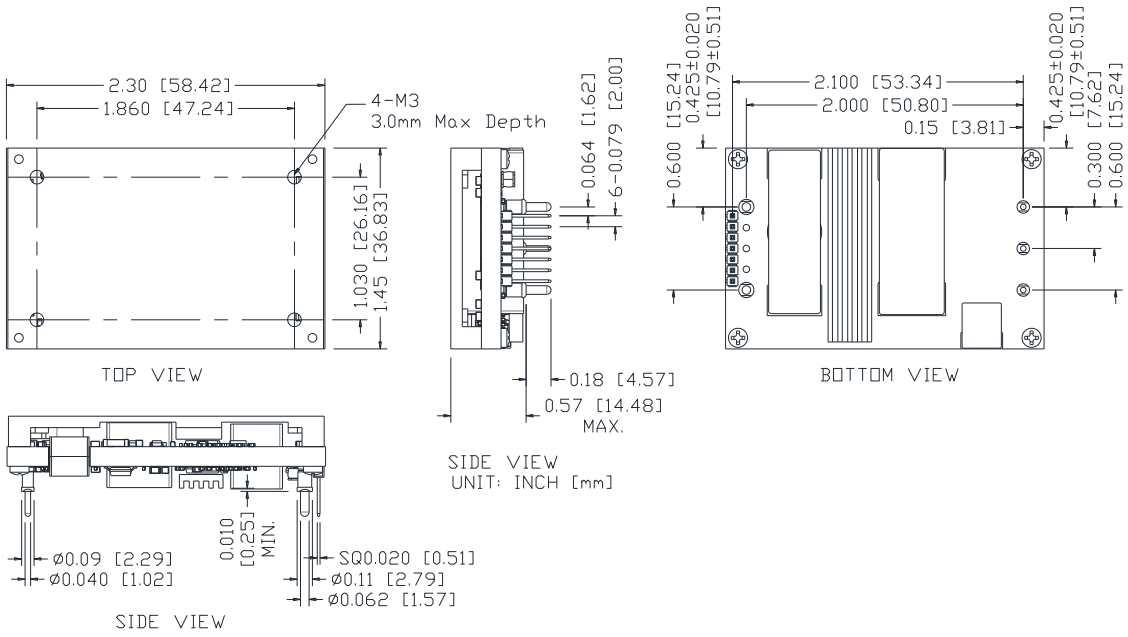


Figure 31. Outline

Note: This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 ºC for less than 5 seconds.

Note:

1) All Pins: Material - Copper Alloy;
Finish - PIN 1/2/3/4/5 tin plated. Others gold plated.

2) Un-dimensioned components are shown for visual reference only.

3) All dimensions in inch [mm]; Tolerances: x.xx +/-0.02 inch [0.5 mm]. x.xxx +/-0.010 inch [0.25 mm]. Unless otherwise stated.

PIN DEFINITIONS

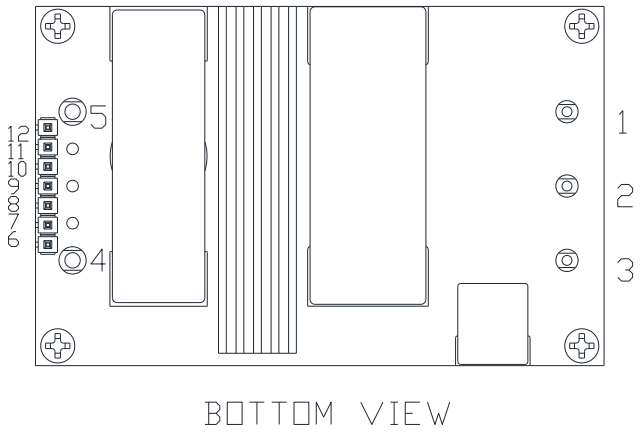


Figure 32. Pins

PIN	FUNCTION	PIN SIZE	PIN LENGTH	PIN	FUNCTION	PIN SIZE	PIN LENGTH
1	Vin (+)	F0.040"	0.180''	7	DGND	SQ0.02"	0.180''
2	ON/OFF	F0.040"	0.180''	8	PMBDATA	SQ0.02"	0.180''
3	Vin (-)	F0.040"	0.180''	9	SMBALERT	SQ0.02"	0.180''
4	Vout (-)	F0.062"	0.180''	10	PMBCLK	SQ0.02"	0.180''
5	Vout (+)	F0.062"	0.180''	11	Addr1	SQ0.02"	0.180''
6	C2	SQ0.02"	0.180''	12	Addr0	SQ0.02"	0.180''

RECOMMENDED PAD LAYOUT

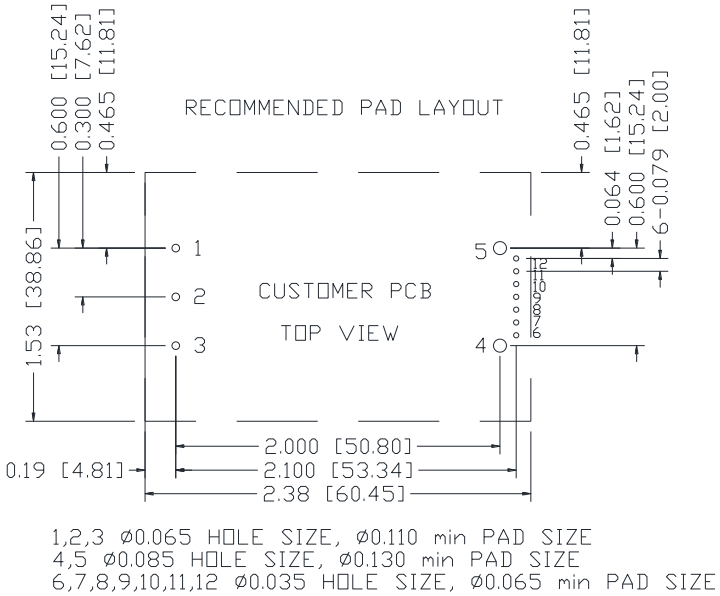


Figure 33. Recommended pad layout

17. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2019-03-15	AA	First release	Z.Tang
2019-07-11	AB	Update efficiency and input voltage rating.	J.Yao
2019-08-21	AC	Update electrical spec	J.Yao
2019-09-12	AD	Update Humidity, Over Temperature Protection, Under Voltage Lockout, Typical Efficiency, Output Trim Equations	J.Yao
2020-06-18	AE	Update mechanical dimensions	J.Yao
2020-09-07	AF	Update input specifications, output voltage set point, turn-on delay(vin), efficiency, MTBF, FIT, altitude, SAFETY&EMC and power management bus information.	J.Yao
2020-12-25	AG	Update mechanical dimensions for deleting Vo sense+/- and TRIM pins. Change module photo.	J.Yao
2021-04-30	AH	Add object ID. Update power management bus information.	J.Yao

For more information on these products consult: tech.support@psbel.com

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